APPLICATION SCENARIO

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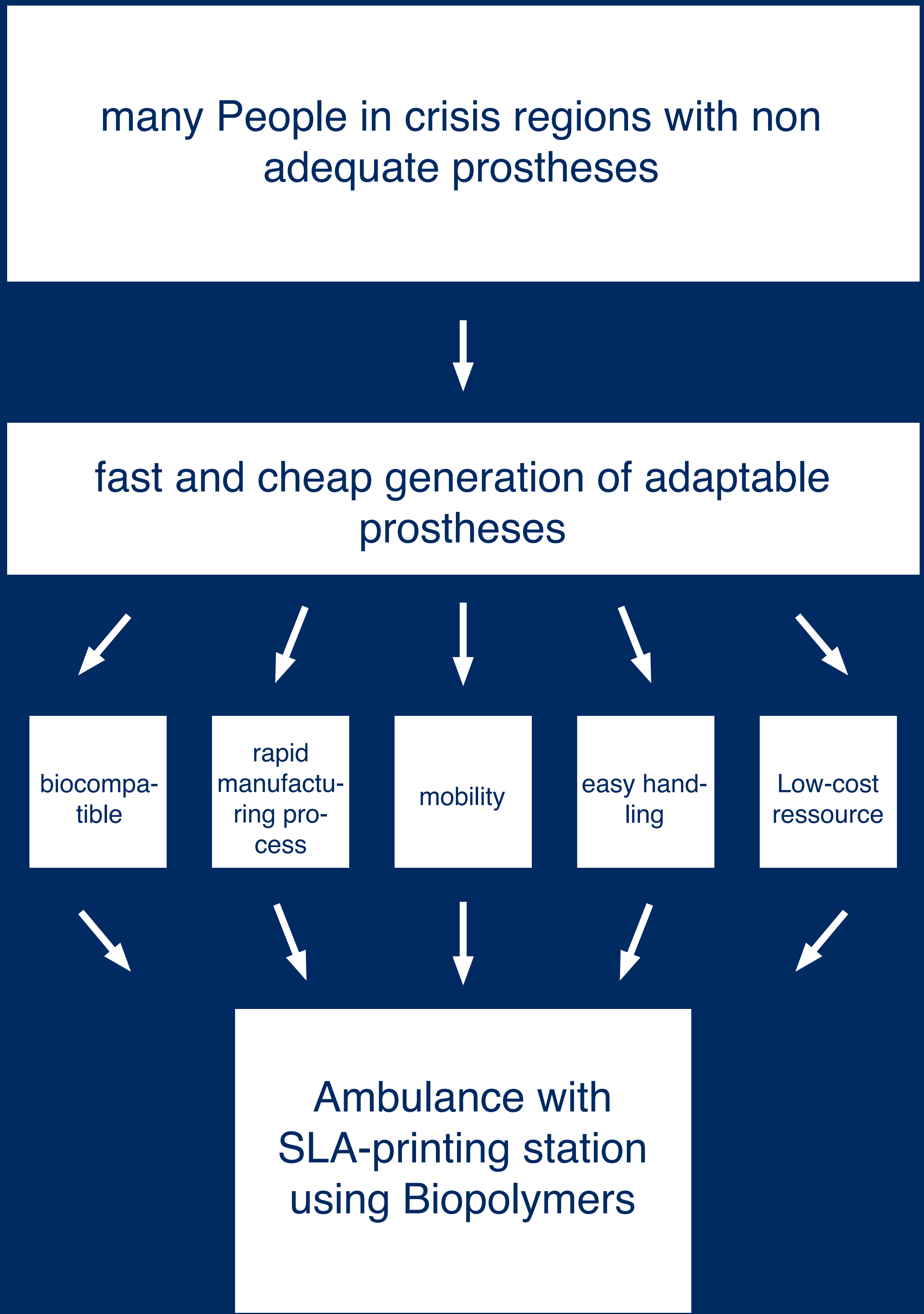
Introduction

Here we present our application scenario. We aim to produce cheap and personalized prostheses for disabled people in crisis regions of the world. Our prostheses are produced by SLA-3D-printing, a method of utilizing light to induce polymerization. With this technique it is able to produce highly detailed structures with adaptable physical properties.



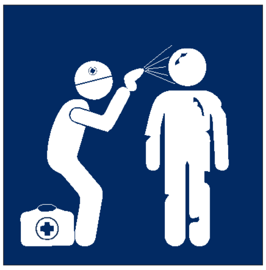
Mode of Action

The first step towards our prosthesis is the biotechnological production of our three monomers (itaconic acid, ethylene glycol and xylitol). We have designed three different genetically modified organisms (GMOs), which are specialized to generate a high amount of respectively one monomer. The production could be done in every industrialized country by a company using bioreactors. This biological way of production must compete with the already existing chemical methods. But it would be no problem if the chemical products won't be cheaper, because we just need the monomers, however they are produced.

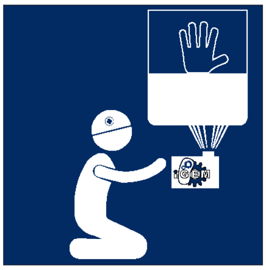
The second step is the chemical connection of the monomers to oligomers. Our monomers can be easily polymerized by mixing them together and using heat. By changing the proportions of monomers the physical properties of the final product can be adapted. The polymerization can be done in the presence of air and yields water as only side product. Thus the polymer could even be produced in a cooking pot. This easy and cheap production could enable the oligomerization in every region of the world. But for standardization it would be recommend producing it at industrial norm and scale.

A tank containing the fluid can be integrated in an ambulance or a separate vehicle, along with a SLA 3D-printer. The printing process only requires electricity for the beamer light and therefore the ambulance can operate without additional supply. The production capability is only limited by the amount of oligomer carried within the ambulance. Of course the printer could also be placed in a hospital. But the biggest advantage of this technology is the mobility.

There are many crisis regions all over the world which lack a required infrastructure and security for the needed supply with prostheses. For example most rural regions of Nepal, which were struck by a huge earthquake, or many regions in Africa where marauding war bands and terrorist groups stride the country and frighten the inhabitants by chopping off extremities. Either through the landscape or the missing/destructed infrastructure, the people in those areas don't really have the opportunity to get a cheap prosthesis, because the costs are too high for poor people.



The creation of our prosthesis starts with scanning the remains of the limb's surface. This is accomplished by using a handheld laserscanner. The limb's surface is mapped by triangulating of the distance between the scanner and the surface. The scanner is connected to a PC via WIFI as well as USB. A Computer aided design (CAD) file is created which is commonly used for rendering of 3D-models. The file is sent to the printer and the printing process is initiated.



The SLA printer now starts the light initiated polymerization process. The tank of the printer contains a fluid mixture of the oligomer and a photoinitiator. If light of a specific wavelength hits the fluid it polymerizes at that spot. Inside the tank there is a platform placed slightly above the bottom (0,1mm). The tank is made out of glass and beneath it there is a beamer which projects a black/white image on the bottom of the tank. The fluid in the small layer between the platform and the bottom polymerizes at the spots which are illuminated (thus a thin 2D image is created). The hardened polymer binds on the platform and the platform is slowly elevated. At the same time the beamer projects new 2D-images on the bottom. This way every possible 3D structure can be created.

With our technology cheap and personalized prostheses can be produced in every region of the world. As a result the disabled people can live more independently and their community is relieved. For this reason the productivity of the underdeveloped regions improves.

Advantages

In contrast to the conventional production of prostheses our production is simpler and thus essentially cheaper. Furthermore our product is biodegradable. The physical properties can be modulated by proportion of our monomers. In the same way the biodegradability can be adapted. Thereby no environmental damages occur caused by left-behind prostheses.

Limits of our invention

Our prostheses are no long term solutions. Were are unable to print articulations so the functionality is limited. In relation to stainless steel the used polymer isn`t as resistant to attrition. Due to this fact our prostheses have to be exchanged after a certain time. Another point is the durability of our polymer under conditions of heat and long time storage. Long term testing has yet to be done.

Risk Assessment

An important aspect often mentioned is the threat of accidental leakage of genetically modified organisms (GMOs) out of a fermenter. This problem gets futile if we look at biotechnological producing of biofuels or humane insulin which is working safe for many years. Although no pathogenic organisms are used. Even in the unlikely case of accidental leakage of our organisms there would be no conceivable aftermath to the environment to be afraid of. Secondly the medical issues caused by infections through bacterial waste in the end product can be excluded. This is related to the purification process following the production process of our monomers. This way it is assured that no organisms can end up in the environment. Furthermore our technology, particularly the construction plans for the SLA-Printer, can be used to print constructs with negative consequences, e.g firearms. Nevertheless, there are already accessable plans for 3D-printers of any kind. Many of them are preferable for printing side arms and additionally our polymer is not suitable as a raw material for weapons.

Financing

Our application focuses on war and crisis regions in underdeveloped parts of the world. For instance in locations where civilians got mutilated for example Somalia and Sierre Leone (1,2). In such cases terroristic groups suppress and frighten minorities by sanguinary chopping off limbs (3). We are going to focus on robust and financially affordable prostheses. The funding will be carried largely by welfare organizations, for example „Amnesty international“ or „doctors without borders“, because of the lack of public aid for the citizens. In addition, the government of Sierra Leone announced in the year 2010 the “Free Healthcare Inititiative” for pregnant women, breastfeeding mothers and children under five, which abolished fees for medical attention for the mentioned groups (4). This Initiative facilitates the application possibilities of our product.

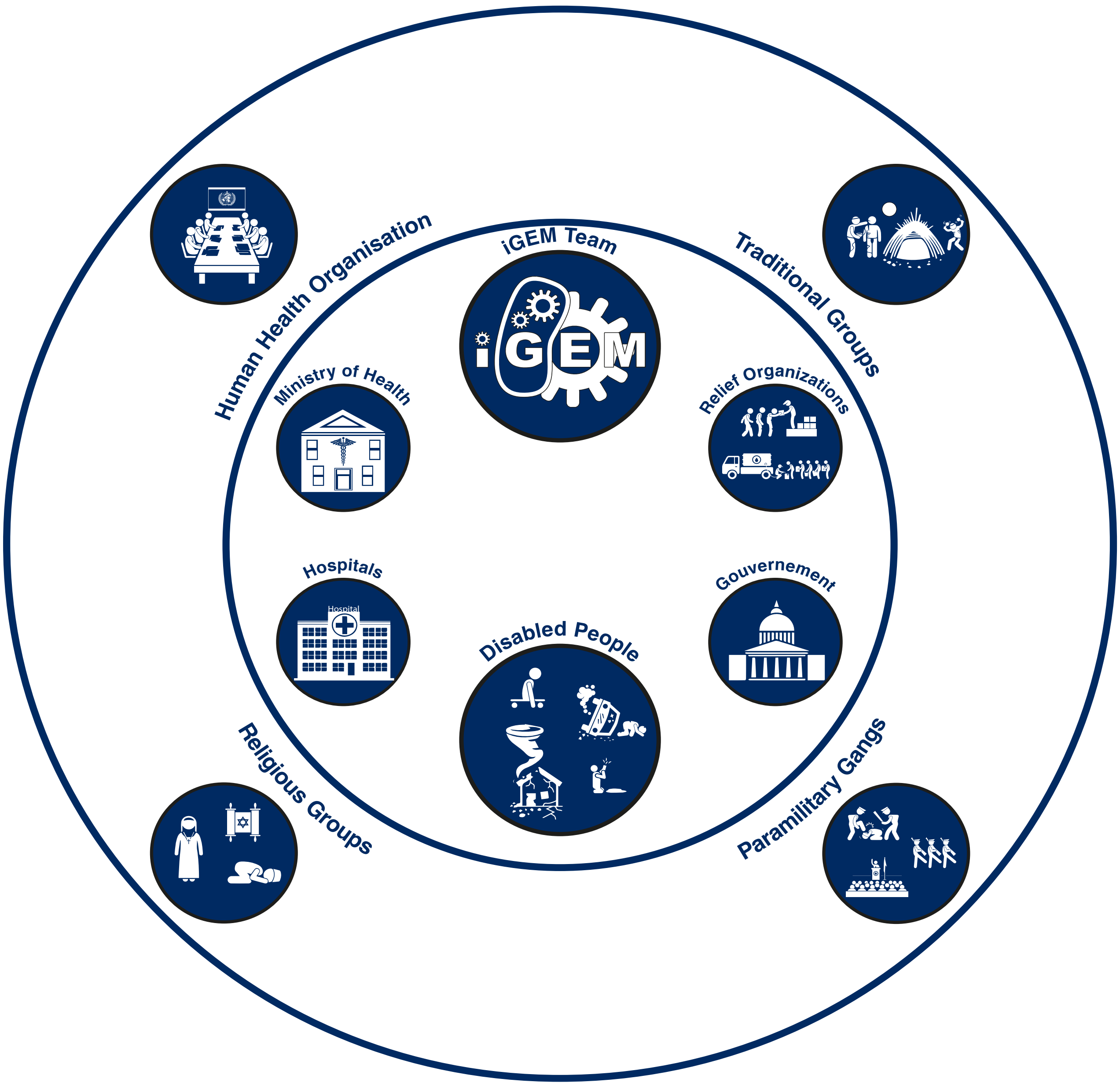
The calculated costs for the raw materials, itaconic acid and PEG200 are 1000$/t and 240 $ /t. (resulting: 625$/t raw material). The average prosthesis weight is estimated with 2kg. Therefore the approximately production costs are located with 1,25$ per average prosthesis. Not included are costs for oligomerization and labor of medical assistance.Therefore we calculate with a total amount of 4$/prosthesis. Due to the low cost raw materials and accessible technical applications the total cost are in appropriate conditions, even for small organizations and hospitals (Stakeholder map shows primary and secondary affected groups).

Every part of our invention (biobricks, chemical reactions and the hardware) are completely open source and can be found on our wiki. No money is earnable, so no commercial interests can be realized. However we give all wellfare organisations the opportunity to use and improve our inventions. The approval of our technique depends on the local law texts. In highly developed countries our product could not be used because it can not meet the requirements. On the other hand in underdevelopped countries conditions for admission are less strict. Our product should be adapted to fit the minimal requirements of the target country in order to be as cost efficent as possible. The limiting factor for wellfare organisations is money.

Conclusion

Our technology has the potential to drastically change the cost and availability of simple prostheses. We hope that our idea can have a beneficial impact on the standard of living of people in developing countries and thereby increasing the worldwide level of equality.

Stakeholder Map



(1) War Wounded and Amputees Association:
https://www.medico.de/der-kampf-um-gerechtigkeit-13005/

(2) The Guardian
http://www.theguardian.com/world/2010/oct/20/somali-islamists-schoolboy-amputation-ordeal

(3) TERRORISM IN AFRICA
Botha & Solomon, Centre for International Political Studies, University of Pretoria

(4) Healt Poverty Action
http://www.healthpovertyaction.org/on-the-ground/africa/sierra-leone/